USDA United States Department of Agriculture

Ecology Highlights

U.S. Forest Service Region 5 Ecology Program 2016-2017

The Pacific Southwest Region (Region 5) Ecology Program serves multiple roles in the Region, including science application to resource management; inventory and monitoring of conditions and trends in vegetation, fire, and fuels; science support to Forest planning; climate change interpretation; statistical and analytical support to Forest and District projects; education and outreach; and assistance to field units, the Regional Office, OGC and the Department of Justice in matters of appeals and litigation.

We are also a national leader in partnerships and collaborative endeavors with other federal and state agencies, universities, and non-governmental organizations. Current Forest Service priorities revolve around Forest planning, ecological restoration, ecosystem services, and response to environmental change and the Region 5 Ecology Program is uniquely positioned and qualified to support these priorities.

In addition to the comprehensive annual report we put out each year, this mid-year Highlights Report provides more detail on selected projects and programs. We hope you enjoy it!

Sincerely,
Hugh Safford, Regional Ecologist

Forest Service

Pacific Southwest Region
Ecology Program

2016/ 2017

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R5 PROGRAM OVERVIEW

The Region 5 Ecology Program (REP) is a science-management boundary spanning organization that provides products and expertise fundamental to sustainable, science-based, multiple-use land management in the Pacific Southwest. The REP's principal purpose is to ensure and enable the application of current ecological science to land and resource management on the National Forests in California. The Regional Program is headed by a GS-13 Ecologist and a GS-12 Assistant Regional Ecologist in the Regional Office. A GS-12 Province Ecologist is stationed on each of five Provinces (zones of three to four National Forests), along with a GS-11 Associate Ecologist. Two cost-share ecologists at the Regional level are co-managed with the University of California-Davis and the California Fire Science Consortium.

Ecology Program Staff and a few partners, Redwood National Park, May 2017

Front row (L to R): Kyle Merriam, Sierra-Cascade Province Ecologist; Shana Gross, Central Sierra Nevada Province Associate Ecologist

Center row (L to R): Kayanna Warren, RO State and Private Forestry ecologist; Becky Estes, Central Sierra Nevada Province Ecologist; Christina Restaino, USFS R5-UCDavis Costshare ecologist; Michelle Coppoletta, Sierra-Cascade Province Associate Ecologist

Back row (L to R): Eamon Engber, Redwood National Park fire ecologist; Phil van Mantgem, US Geological Survey; Ramona Butz, Northern California Province Ecologist; Marc Meyer, Southern Sierra Nevada Province Ecologist; Gabrielle Bohlman, Northern California Province Associate Ecologist; Amarina Wuenschel, Southern Sierra Nevada Province Associate Ecologist; Hugh Safford, Regional Ecologist; Johnny Mac, Redwood National Park. Missing: Nicole Molinari, Southern California Province Ecologist.

Red Fir Forest Health, Structure, and Diversity with Active Fire Regime Landscapes of California

Project Goals:

The goal of our study is to compare the health, structure, and understory diversity of red fir stands in fire-excluded and active fire regime landscapes to understand the potential benefits of fire for red fir forest ecosystems. We also aim to quantify the Natural Range of Variation (NRV) in stand structural and forest health conditions in contemporary red fir forests located within active fire regime landscapes of California.

Red fir stands burned at low, moderate, or high severity showed greater understory diversity than nearby unburned patches.

Key Findings

- Burned red fir stands were characterized by lower tree densities and canopy cover, greater mean tree diameter, and fewer tree clusters than unburned stands.

- Twice-burned stands were also higher in understory plant diversity, including herbaceous plants, shrubs, and tree regeneration. Forest health indicators, such as dwarf mistletoe or live crown ratings, were similar between burned and unburned sites.

- Our results suggest that use of wildland fire may restore red fir forest structure and understory composition within active fire regime landscapes, but it may not influence red fir forest health in areas of greater projected climate exposure. Nevertheless, the reintroduction of fire as a natural process builds adaptive capacity in red fir forests by enhancing structural complexity, reducing fuel loading, promoting regeneration and genetic diversity, and generally increasing forest resilience.

This twice burned red fir stand contained numerous large trees and diverse understory cover that exhibited high spatial variation. Note the presence of individual large trees (foreground), small tree clusters (background left), and a small canopy gap (far background right).

Project Overview

The Natural Range of Variation (NRV) concept is a critical part of the Forest Plan Revision process currently underway for the national forests of California. Contemporary, unlogged landscapes with an active fire regime provide ideal reference sites for quantifying the NRV with respect to stand and landscape-level variables in California forests. Recent studies within these active fire regime landscapes have provided numerous insights in the NRV of mixed conifer and yellow pine forests, but currently this information is lacking for red fir (*Abies magnifica*) forest ecosystems in the state. Such information is timely since many red fir forests in the region are exhibiting clear signs of elevated moisture stress and declining health. We addressed this information need by quantifying stand structure, composition, and health in reference red fir forests that have burned within their historic fire return interval. Our aim is to provide estimates of the NRV of red fir forest structure and health across a range of red fir forest types, topographies, and geographic provinces of California. Results from this study are supportive of Forest Plan Revision efforts for California's national forests.

Reintroduction of fire as a natural process builds adaptive capacity in red fir forests by enhancing structural complexity, and reducing fuels, and generally increasing forest resilience.

Twice-burned red fir forest stands were more open, heterogeneous, and diverse than neighboring unburned stands, although there was no difference in health indicators between these areas.

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Southern Sierra Province, Region 5 Ecology Program, USDA Forest Service
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South Sierra Shared Service Area, Forest Health Protection, USDA Forest Service
Malcolm North
Pacific Southwest Research Station, USDA Forest Service
Tony Caprio, Douglas Smith, Calvin Farris
National Park Service

Dinkey Collaborative Forest Landscape Restoration Project Science and Monitoring Symposium

The Regional Ecology Program worked with partners to organize this symposium, whose goals were to review key monitoring and research results from the first five years of forest restoration treatments on the Dinkey Collaborative Landscape and discuss approaches for improving multiparty monitoring and research efforts in the Sierra Nevada.

The Dinkey Collaborative Forest Landscape Restoration Project (part of the USDA Forest Service Collaborative Forest Landscape Restoration Program) Science and Monitoring Symposium was a two-day event held in Clovis, California that brought together scientists, land managers, and interested stakeholders. Presentations at this symposium covered five broad themes related to forest restoration, including ecosystem resilience, forest heterogeneity, wildlife ecology and habitat management, traditional ecological knowledge, and socioeconomic benefits of landscape-scale restoration. Scientists and other experts presented regional and site-specific information on each of the five themes and discussed implications for forest management. This symposium concluded with an engaged discussion on forest management approaches and agreed upon the overriding importance of science-management partnerships and monitoring information in facilitating adaptive management.

Key Points

- Research findings emphasized the importance of several features that characterize resilient forest ecosystems, including intact fire regimes, structural heterogeneity, presence of large structures (e.g., trees, snags), reduced tree densities, and the alignment of soil moisture availability with forest structure and composition.
- Other presentations underscored the value of traditional ecological knowledge and holistic management techniques in managing meadow and hardwood ecosystems, including the use of cultural burning practices. In addition, presentations outlined the importance of forest restoration activities for providing socioeconomic benefits to local communities within the Dinkey Collaborative Landscape.

A field visit to the Dinkey Collaborative landscape involved the discussion of cooperative research and monitoring efforts in the area.

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Partners: Susan Roberts, Dinkey CFLRP Monitoring Coordinator

Stan Van Velsor, The Wilderness Society

Juliana Birkhoff and Dorian Fougeres, Center for Collaborative Policy, California State University—Sacramento

High Sierra Ranger District, Sierra National Forest

Dinkey Collaborative ((http://www.fs.usda.gov/detail/sierra/landmanagement/planning/?cid=stelprdb5440860)

Livestock Use Has Mixed Effects on Slender Orcutt Grass in Northeastern California Vernal Pools

Grazing is often considered a threat to rare species that inhabit vernal pools. We monitored the effects of livestock use on a federally listed vernal pool plant, slender Orcutt grass (*Orcuttia tenuis*), on the Modoc National Forest in northeastern California by comparing plants in plots where livestock had been excluded with plots where grazing occurred.

Key Points

- Slender Orcutt grass abundance was most strongly influenced by year, suggesting that patterns of precipitation have the biggest effect on this species
- In dry years livestock use had no effect on slender Orcutt grass
- In other, more productive years, livestock may have benefited slender Orcutt grass by reducing litter accumulation

Slender Orcutt grass is a federally listed annual grass found only in vernal pools.

Cattle grazing vernal pools in northeastern California.

By considering factors such as site conditions and season of grazing, land managers can balance the needs of sensitive vernal pool species with livestock utilization.

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Full publication: Merriam, K.E.; M.C. Gosejohan; P.J. Weisberg, K.M. Bovee. 2016. Livestock use has mixed effects on slender Orcutt grass in northeastern California vernal pools. *Rangeland Ecology and Management.* 69: 185-194.

Connecting Drought Stress to Stand Structure and Forest Health Treatments in Southern California

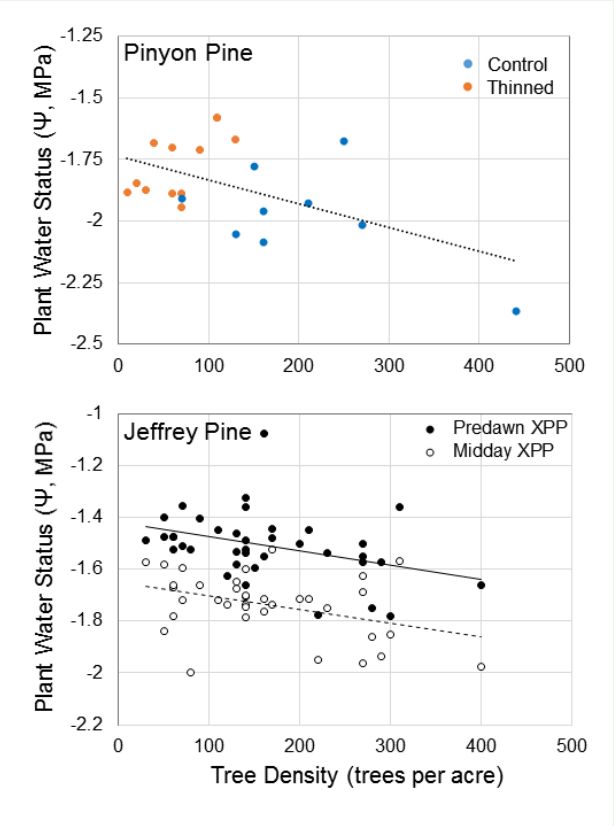

Figure 1. **Top panel: Predawn stem water status of Pinyon pine in relation to stand density and treatment type. R^2=0.27, P=0.015. Bottom panel: Predawn and midday stem water status for Jeffrey pine. Predawn; R^2=0.14, P=0.022. Midday; R^2=0.15, P=0.019. Y-axis refers to the xylem pressure potential of stems. The more negative values indicate higher drought stress or less access to water.**

Key Outcomes

* Treated pinyon stands were less dense and had lower cover of trees, shrubs and herbs. Access to soil moisture was greatest (as measured by predawn XPP) in treated stands with few trees and low tree and herb cover (Fig. 1). Shrub cover did not impede water availability to pinyon pines.
* Midday XPP measurements on pinyon were not affected by stand structure or previous treatment history. This may be due to the conservative daytime water use of this species, which increases its vulnerability to carbon starvation.
* Soil water availability (predawn XPP) and daytime water use (midday XPP) in Jeffrey pine was affected by stand density, such that denser stands experienced less access to soil water resources and higher drought stress (Fig. 1).
* The current drought conditions have resulted in widespread conifer mortality across the Mt. Pinos ranger district. We intend for these plots to function as long-term data sources to track the effects of drought on pinyon and Jeffrey pine stands. In addition, the active management at Frazier Mountain provides a unique opportunity to track the effects of forest thinning on water status and tree survivorship.

Figure 2. **Pinyon pine stands on Frazier Mountain, August 2016.**

Project Overview

The scarcity of forested landscapes in southern California makes them a focus for conservation and science-based land management practices. Despite the high level of commitment to retaining the integrity of forested lands, their long-term resilience is being challenged by high severity wildfire, drought and beetle attack. Large tracts of conifer dominated forests on the Mt. Pinos Ranger District of the Los Padres NF have not experienced fire in over 100 years (Fig. 3), leading to a high concentration of small, often shade-tolerant tree species intermixed with mature individuals and a deep layer of litter and woody material on the ground. In some areas, the accumulation of fuel and vegetation has reached unprecedented levels, increasing the risk of catastrophic wildfire. Competition for water in overcrowded forests may intensify stand die-off due to drought and bark beetle attack. To counteract these effects, the Los Padres NF initiated the Frazier Mountain Project, which is designed to simultaneously reduce the likelihood of high intensity wildfire and increase forest health and resilience in the face of a changing climate.

Jeffrey pine was affected by stand density, such that denser stands experienced less access to soil water resources and higher drought stress.

To evaluate the effects of stand structure and fuel treatments on drought stress, we established 62 plots in forested stands dominated by pinyon (*Pinus monophylla*) and Jeffrey (*Pinus jeffreyi*) pine on Frazier Mountain (Fig. 3). Pinyon dominated plots occupied lower elevations of Frazier Mountain with half of the plots thinned in 2014-2016 and the other half serving as untreated controls (Fig. 2). Forty-one plots were established at higher elevations in Jeffrey pine stands with the goal of collecting baseline data before thinning and prescribed fire begins in FY2017. Common stand exams, Brown's fuels transects and predawn (0200-0500 hours) and midday (1200-1430 hours) xylem pressure potential were measured within in each plot. Xylem pressure potential (XPP) was measured with a Scholander pressure chamber during the driest time of the year- early-September. XPP can be used as a proxy for soil water availability (predawn measurements) and degree of physiological stress (midday measurements).

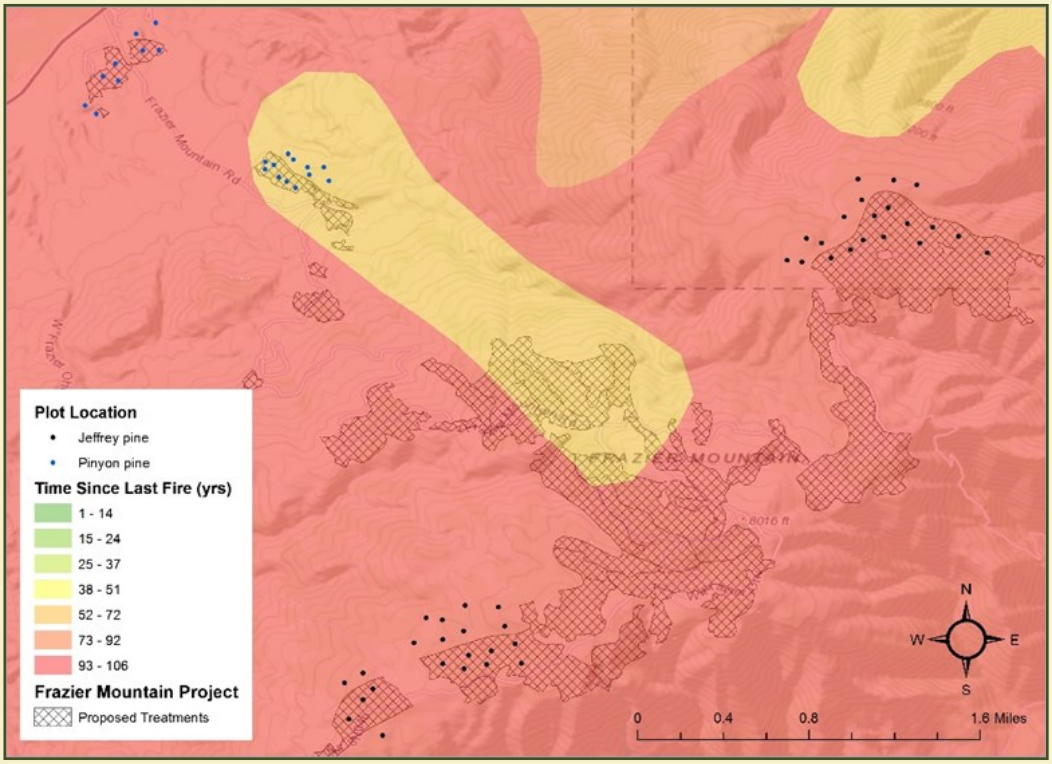

Figure 3.
Frazier Mountain forest health project on the Los Padres National Forest. Fire history data provided by FRID (Safford & Van de Water, 2014).

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Partners: Greg Thompson, Forester, Los Padres National Forest
Nic Elmquist, Fire and Fuels Specialist, Los Padres National Forest

Restoring Meadows and Aspen Stands after the Moonlight Fire on the Plumas National Forest

Surveying aspen stands in the Moonlight Fire.

Although meadows and aspen stands constitute only a small fraction of Sierra Nevada habitats, they play a disproportionately large role in maintaining ecosystem function and biodiversity across the landscape. Unfortunately, many Sierra Nevada meadows are highly degraded due to hydrologic alteration, and aspen stands are declining as they are replaced by conifers due to changes in fire regimes. Beginning in 2014, ecologists from the Sierra Cascade Province partnered with Plumas National Forest botanists and hydrologists on a large-scale effort to inventory, monitor, and restore hundreds of acres of meadow and aspen habitat impacted by the 2007 Moonlight Fire.

Incised stream channel along Willow Creek, Plumas National Forest

Why do meadows and aspen stands need to be restored?

Functional meadows act as regulators of water and sedimentation for the overall landscape, reducing downstream flooding and erosion. They filter out metals and pollutants, improving water quality. They provide habitat for many wildlife species and support greater biodiversity than the surrounding conifer forests.

Aspen stands also provide critical wildlife habitat and support high avian and understory riparian biodiversity. Aspen add nutrient-rich litter to and help stabilize the soil.

How did the Moonlight Fire affect these ecosystems?

The 2007 Moonlight Fire burned approximately 65,000 acres of Sierra mixed conifer forests, hardwood stands, shrublands, meadows, and riparian areas. Meadows and aspen stands on Forest Service land within the fire perimeter make up about 195 and 568 acres, respectively.

The fire benefited meadows and aspen stands by eliminating encroaching and overtopping conifers; however, many meadow and aspen sites were unburned or burned at low severity, which was not enough to reduce heavy conifer encroachment. Additionally, other pressures (e.g. livestock grazing) affecting the viability and ecological condition of stands are still present and active.

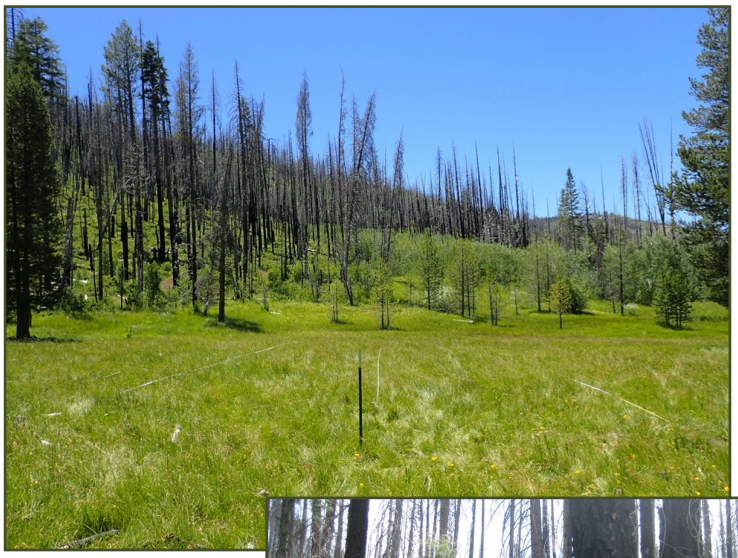
Project Overview

Although meadows and aspen stands constitute only a small fraction of Sierra Nevada habitats, they play a disproportionately large role in maintaining ecosystem function and biodiversity across the landscape.

In 2014, we conducted rapid field surveys of 57 meadows and 114 aspen stands within the 2007 Moonlight Fire on the Plumas National Forest. We found that 58 percent of the meadows showed signs of stream channel degradation, 80 percent had some amount of conifer encroachment, 65 percent had evidence of livestock trampling or grazing, and 58 percent had infestations of the invasive weed, Canada thistle (*Cirsium arvense*). Over 80 percent of all aspen stands showed signs of conifers overtopping or encroaching the stand and almost 75 percent of stands showed signs of deer and/or livestock browsing. In all, almost three-quarters of the 114 aspen stands were considered to be at moderate or greater risk of loss on the landscape. These data were used to prioritize at-risk meadows and aspen stands for restoration. In 2015 we established long-term monitoring plots to track the effectiveness of restoration activities at promoting biodiversity and maintaining the unique ecosystem functions that these important habitats provide.

In 2016, Forest Service land managers used this prioritized list to direct more detailed data collection at priority sites and to inform specific restoration actions. Some of the restoration activities managers are currently considering include:

- stream channel stabilization to restore channel function;
- removal of encroaching and overtopping conifers to reduce competition for water, light, and nutrients;
- fencing and other livestock management practices to reduce trampling and over browsing; and
- noxious weed removal (specifically Canada thistle).



Long-term meadow monitoring plot in the Moonlight Fire.

Meadow vegetation thriving with reduced conifer competition after fire.

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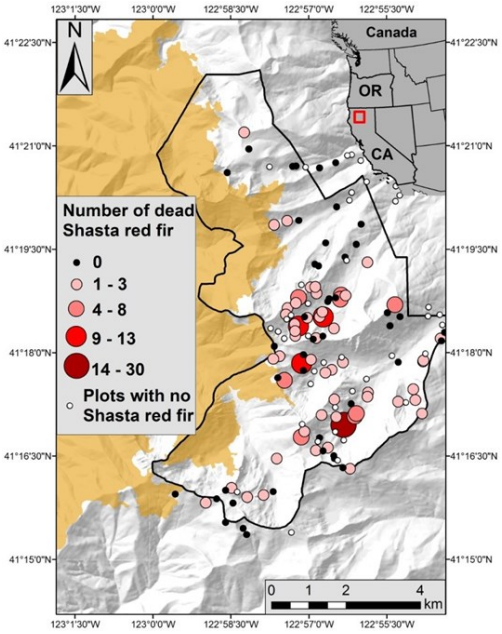
Reports and Related Documents:
Proposed aspen treatments: Moonlight Fire Area Restoration Project
https://www.fs.usda.gov/project/?project=49421

Proposed meadow treatments: Moonlight Range Allotment Project
https://www.fs.usda.gov/project/?project=41559

Recent Tree Mortality Patterns and Drivers in Diverse Conifer Forests of the Klamath Mountains, CA



Map of the study area, including the location of the 142 circular survey plots. Colored points represent plots with Shasta red fir (*Abies magnifica* var. *shastensis*) mortality, and size and shading indicate the extent of mortality. The black line denotes the boundary of the Russian Wilderness and the shaded yellow area represents the extent of the Whites Fire, which burned in summer 2014.

Goals

Tree mortality rates are increasing in North America, yet our understanding of the processes affecting mortality across different tree species is limited. The primary objective of our study was to quantify the level of recent conifer mortality in the Russian Wilderness, an area in the Klamath Mountains in northern California with the highest conifer diversity in the world, and to better understand what processes are contributing to recent mortality.

John Sawyer (back) and Dale Thornburgh (front) climbing through chaparral near South Sugar Lake in the Russian Wilderness in summer 1969. Photograph by Steve Selva.

Project Overview

Our study was motivated by a recent observation of widespread die-off of Shasta red fir (*Abies magnifica* var. *shastensis*) in the Klamath Mountains of northern California (Figure 2). The Shasta red fir variety of the red fir complex (*A. magnifica*) is a hybrid between California red fir (*A. magnifica* var. *magnifica*) and a more northern species, noble fir (*A. procera*). Throughout its range, red fir typically inhabits upper elevation (>2000 m) mesic slopes with substantial winter snow. To date, very little is known about the extent or cause of recent mortality of Shasta red fir in the Klamath Mountains.

In summer 2015 we established 142 11.37 m radius (1/10 acre) circular plots within the study area. Plot locations were originally selected in 1969 as part of a study designed to describe the region's vegetation by Sawyer and Thornburgh. At each plot we recorded site characteristics including elevation, slope, aspect, topographic position, and slope configuration. Within each plot, we measured all canopy trees and snags and recorded species, status (live, sick, and dead), diameter at breast height (dbh), and noted all identifiable forest insects and pathogens. We recorded any visible fungal cankers, conks, or rusts, and identified them to species whenever possible. In this study, we focused on eleven conifer species for which we had adequate data to assess patterns of mortality (>60 trees). We also derived climate data from 1951-2014 using the California Basin Characterization Model (BCM), a spatially explicit hydrologic response model, to assess climate changes over time.

Key Findings

- Our field team surveyed 3,446 trees across 142 plots in the Russian Wilderness, of which 22% were recently dead.
- Approximately 18% of the live trees in our census were classified as "sick" (dying), comprised mostly of Shasta red fir (61%) followed by mountain hemlock (21%). Across all taxa, the proportion of sick and recently dead trees was approximately 12%.
- Mortality varied significantly by species, with the highest proportion of recently dead and sick trees for subalpine fir (28.3%), Shasta red fir (20.7%) and lodgepole pine (18.7%). Engelmann spruce (*Picea engelmannii*), ponderosa pine (*Pinus ponderosa*), and Douglas-fir (*Pseudotsuga menziesii*) had the lowest levels of recent mortality.
- We detected signs of bark beetle activity on 13.1% of all trees (live and dead. Bark beetles were highest for Shasta red fir (34.7%) and whitebark pine (21.3%).
- 14.4% of all live trees contained dwarf mistletoe with significant variation between species: ponderosa pine (24.6%), mountain hemlock (21.7%) and Shasta red fir (20.4%).
- Over 70% of sick (dying) Shasta red fir trees contained dwarf mistletoe. We detected dwarf mistletoe on Shasta red fir individuals in all size classes, but mistletoe infestation was highest in the smallest size class (< 20 cm dbh).
- For all three species with high levels of recent mortality (Shasta red fir, subalpine fir and lodgepole pine) bark beetles were a significant predictor of mortality. Because we did not track trees over time, however, we cannot distinguish between bark beetles that infested live trees, versus those that colonized when the tree was recently dead.

For all three species with high levels of recent mortality (Shasta red fir, subalpine fir and lodgepole pine) bark beetles were a significant predictor of mortality.

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A typical Shasta red fir (*Abies magnifica var. shastensis*) stand within the study area with substantial damage from dwarf mistletoe (*Arceuthobium* spp.) and fir engraver beetle (*Scolytus ventralis*).

Filling Knowledge Gaps in California Spotted Owl Science

Initial efforts to develop a robust Conservation Strategy for the California Spotted Owl (CSO) have highlighted some key scientific gaps in our understanding of CSO ecology and vulnerabilities. To address some of these gaps we have partnered with researchers at multiple institutions to produce new, management relevant, CSO science.

Male California Spotted Owl. Photo Credit: Justin Winsor

Key Points

- Key scientific gaps to address critical management questions exist
- We are working with managers and scientists to highlight key questions
- We are then providing support to scientists working to address these key questions
- New science includes focus on:
    - CSO response to disturbance
    - Addition of more management relevant habitat variables to CSO habitat selection analyses
    - Evaluation of future risk to CSO habitat under changing climate and fire regimes and population response to various risk-reduction scenarios

Overview: Science-Management partnerships are critical to developing effective, scientifically founded, management and conservation recommendations. We are focusing efforts on bringing management needs and scientific information together to support the long-term conservation of the California Spotted Owl (CSO). Conservation of this old-growth dependent species, often in highly modified ecosystems and under ever changing conditions, poses many challenges.

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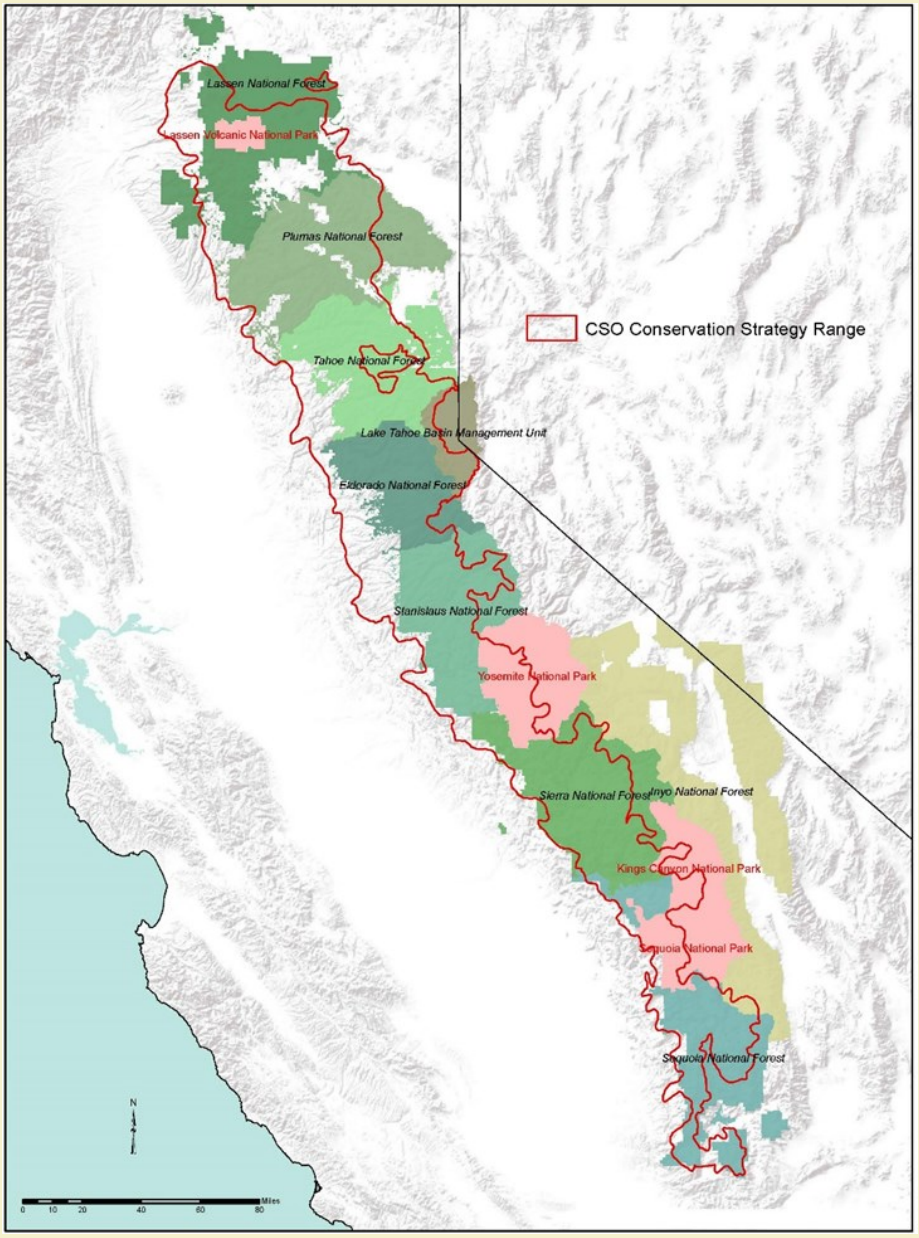
Scientific analyses, building on over twenty years of owl demographic and fire data collection, as well as new information on historic ecosystem structure, function, and composition, can help address these challenges.

We are currently partnering with experts at the University of Wisconsin, University of California-Berkeley, University of California-Merced, Pacific Southwest Research Station, and the University of Washington to fill critical scientific gaps to inform CSO Conservation. Taking advantage of a natural experiment of sorts, researchers at the University of Wisconsin are assessing the impacts of high severity fire on owl occupancy. Making use of relatively new data products like GNN mapping, researchers at PSW and University of Wisconsin are shedding new light on habitat selection by CSO. Combining fire modeling techniques with downscaled climate models and spatially explicit CSO occupancy models, researchers at UC-Merced and University of Wisconsin are evaluating risks and rewards of various restoration scenarios on long-term CSO population viability. Finally, we have, in partnership with the Conservation Biology Institute, brought together a group of researchers to synthesize scientific information on habitat resilience to inform management decision making.



Spatial Distribution of Temperature Extremes for the California Spotted Owl

The Southwest Climate Science Center (SWCSC) Climate Extreme Group collaborated with the Forest Service to apply spatial climate datasets to resource management. The aim of the project was to investigate climate extremes relative to the thermal tolerance of the California Spotted Owl, a target management species sensitive to higher temperatures. By identifying where temperature extremes are exceeded now and in the future we can prioritize where to manage for the species.

GOAL

The thermal tolerance dataset provides one method for considering connectivity and potential climate refugia for the CA Spotted Owl—and species with similar thermal tolerances—in order to assess future vulnerability and adaptation. The USFS planning rule has specific requirements for addressing climate change in each phase of planning, and this dataset helps to meet those requirements.

PRODUCT

A dataset that can be used to identify where the number of days crossing critical temperature thresholds for owls is increasing or is projected to increase over time. The datasets developed can be accessed internally through the Forest Service Network at: T:\FS\NFS\R05 \Program\Ecology\GIS\RegionWide\SpottedOwlClimateExtreme.

OVERVIEW

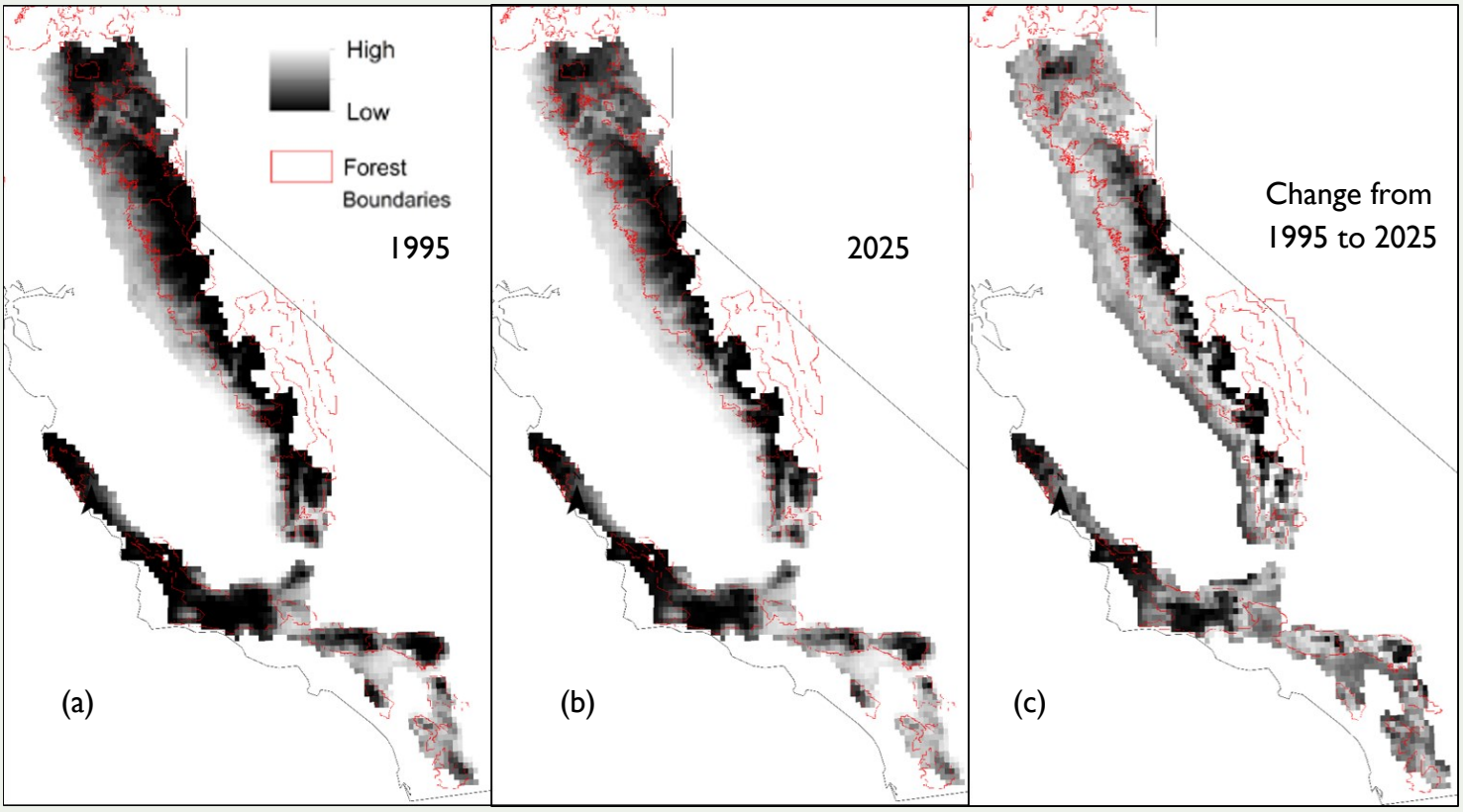
The SWCSC climate extreme project is supported by the Southwest Climate Science Center (US Geological Survey) and University of California, Davis. The project had three complementary parts. The SWCSC climate extreme group screened regional downscaled climate models on the basis of their ability to represent regional (as opposed to national) extremes, they developed a platform for delivery of climate data that allows users to customize what the models derive, and they collaborated with small teams of managers to apply data on extremes to decision-making.

The California Spotted Owl is sensitive to temperatures at or above 30^0C. At temperatures at or above 30^0C body temperature elevates and body width index (ptiloerection) increases. At temperatures at or above 32^0C breathing rate increases. At temperatures at or above 34^0C, gular fluttering, gaping, and drooping of the wings occurs. The upper critical temperature for the California Spotted Owl is 35.2^0C, where resting metabolic rate increased exponentially (Weathers et. al 2001).

The climate extreme group processed an ensemble of statistically downscaled (6 km resolution, based on gridded interpolations from station observations) GCM simulations using the localized analog statistical downscaling method (LOCA; http://loca.ucsd.edu/). The climate extreme group then derived climate extreme metrics based on two Representative Concentration Pathways (RCP) emission scenarios and ten climate models. The total number of days between May through September where the daily maximum temperature exceeded CA Spotted Owl threshold temperatures (30^0C, 34^0C, and 35.2^0C) was calculated for each grid cell. Raster data were produced based on the median value of the ten model results at each LOCA grid-point in California for each emission scenario and each year from 1985 to 2025. The resulting data were produced at the state scale, which can provide information on potential suitable temperature locations outside of the existing distribution.

This dataset is available for managers to evaluate and utilize during decision making. An example is provided (below) of how the dataset may be used to show if and where the number of days crossing critical thresholds is increasing or is projected to increase over time. The spatial distribution of temperatures exceeding 30°C was explored using 1985 and 2025 data from one of the emission scenarios for the current spotted owl distribution (See Figure). The current spotted owl distribution was determined using USGS National Gap Analysis Program distribution data for the CA spotted owl https://gapanalysis.usgs.gov/species/data/download/.

In the figure provided below, there is a notable increase in the number of days exceeding thermal tolerance across the species distribution. The maximum number of days exceeding 30°C between May and September was projected to increase from 144 to 146.5 (+1.7%) between 1985 and 2025. The NW section of the northern distribution and the SW portion of the southern distribution are at the greatest risk of reaching and exceeding temperature tolerances. The Los Padres, Lake Tahoe Basin, and eastern portions of the Eldorado, Tahoe, Stanislaus, and Sierra National Forests provide the greatest temperature refugia below 30°C within the current distribution at the scale of this analysis.



Median value of the total number of days between May through September for which the daily maximum temperature exceeded the threshold temperature of 30°C based on an ensemble of 10 global climate models and the RCP 4.5 emission scenario. Data are presented from 1995 (a), 2025 (b), and the change between 2025 and 1985 (c). The lighter colors indicate a greater number of days exceeding the threshold temperature. The red polygons represent current National Forest boundaries.

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Key Partners: Erica Fleishman, University of California, Davis; Dan Cayan, Sasha Gershunov, and Dave Pierce, Scripps Institution of Oceanography; Kelly Redmond, Desert Research Institute

Monitoring Strategy of the Cornerstone Collaborative Forest Landscape Restoration Project (CFLRP)

The Cornerstone monitoring strategy describes the long-term monitoring questions and indicators that were formulated to evaluate achievement of the CFLRP goals and objectives. It was developed by working group members with major involvement by Regional Ecology Program staff.

The Collaborative Forest Landscape Restoration (CFLRP) program was established under the Public Land Management Act of 2009, to better integrate ecological, social, and economic needs during restoration on National Forests. The Amador-Calaveras Consensus Group (ACCG) Cornerstone CFLR project was awarded in February 2012, with the core goals of moving landscapes towards sustainable conditions, reducing uncharacteristic wildfire, restoring a range of ecological functions, and maintaining rural communities and livelihoods.

One of the requirements under the CFLRP funding is to conduct ecological, economic, and social monitoring to track restoration efforts in the Cornerstone project area. This monitoring strategy is a living document that was compiled through a collaborative process. The strategy describes the process that developed the CFLR monitoring questions, identifies current and desired conditions, and defines sampling methods and data analyses to inform management actions.

The strategy additionally includes monitoring matrices that contain the core information for the monitoring program, including monitoring questions and associated Cornerstone objectives, indicators to be measured, indicator target conditions, adaptive management thresholds, and data sampling methods. For some matrices, spatial considerations and sampling guidelines are provided.

Next steps in the process include the implementation of the strategy by prioritizing and carrying out recommended monitoring.

The Cornerstone monitoring strategy includes 41 questions in the following monitoring categories:

- Implementation – 1 question,
- Collaborative – 4 questions,
- Ecological Effectiveness – 30 questions,
- Social/Economic – 6 questions.

The workgroup also recognized the need to prioritize limited monitoring resources; therefore, the 30 ecological effectiveness monitoring questions were prioritized into priority tiers, where the tiers represent the order in which questions should be addressed.

	Number of Questions			
Discipline	Tier 1	Tier 2	Tier 3	Tier 4
Aquatic Wildlife	1		2	
Conifer Forested Communities	2	1	1	
Cultural Resource	1	1	2	1
Fire and Fuels	2			1
Hardwoods	1			
Noxious/Invasive Plants	1		1	
Riparian and Special Aquatic Features	1			1
Sensitive Plants	1		1	
Soils		1	1	
Terrestrial Wildlife	1		1	
Watershed	1		3	
Total	12	3	12	3

Tier 1: Core questions to address. Monitoring will be funded by Cornerstone dollars when feasible.
Tier 2: Core questions to address. Monitoring will be funded by other means (existing programs, grants, volunteers, etc). Funding or responsible monitoring parties were identified for these questions.
Tier 3: Secondary monitoring questions to address once funding is identified.
Tier 4: Secondary questions that would provide valuable information, but are likely not needed for adaptive management and would require expensive data collection methodologies or rely on a large scale disturbance prior to monitoring.

Red Fir monitoring at the Hemlock project on the Calaveras District, Stanislaus National Forest. Red Fir monitoring was the first monitoring funded directly through the Cornerstone Project.

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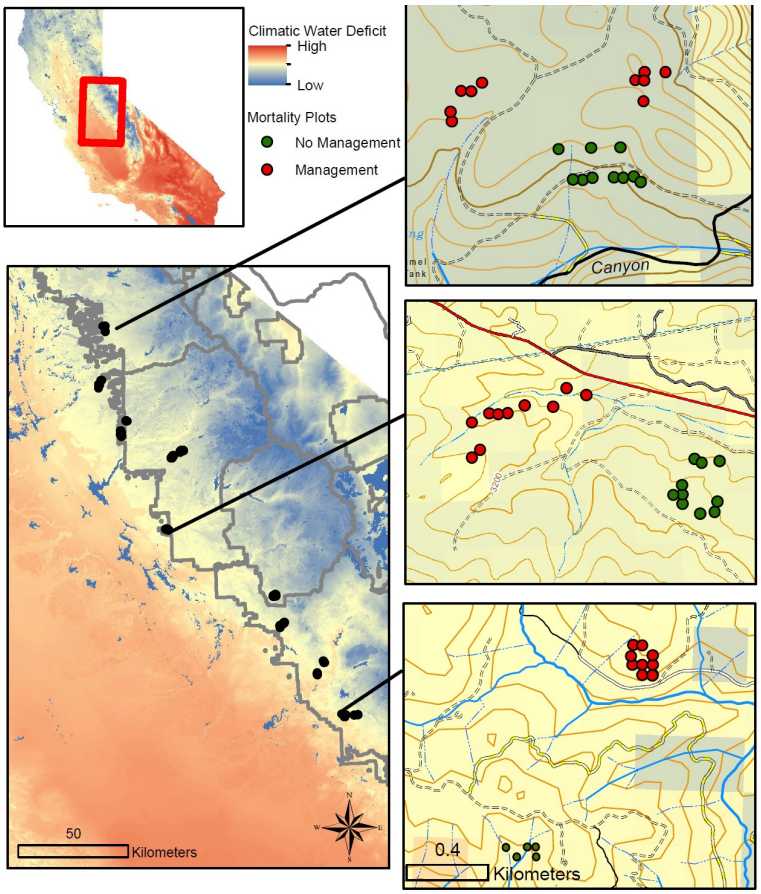
Shana Gross, Central Sierra Province Associate Ecologist, segross@fs.fed.us for more information

Were treated forests more resistant to the 2012-2015 bark beetle epidemic in the Sierra Nevada?

Extreme drought stress and unprecedented bark beetle population growth contributed to the extensive tree mortality event in California, resulting in more than 100 million trees dead as of late 2016. Although changes in climate are an important driver of this mortality event, past management activities and the consequent densification of California forests have also contributed. In some areas, land management agencies have worked to reduce stand density through the use of mechanical treatments and prescribed fire with the goal of restoring forests to more open conditions that are thought to be more resilient to disturbance and changes in climate.

A field technician measures the diameter of a dead pine



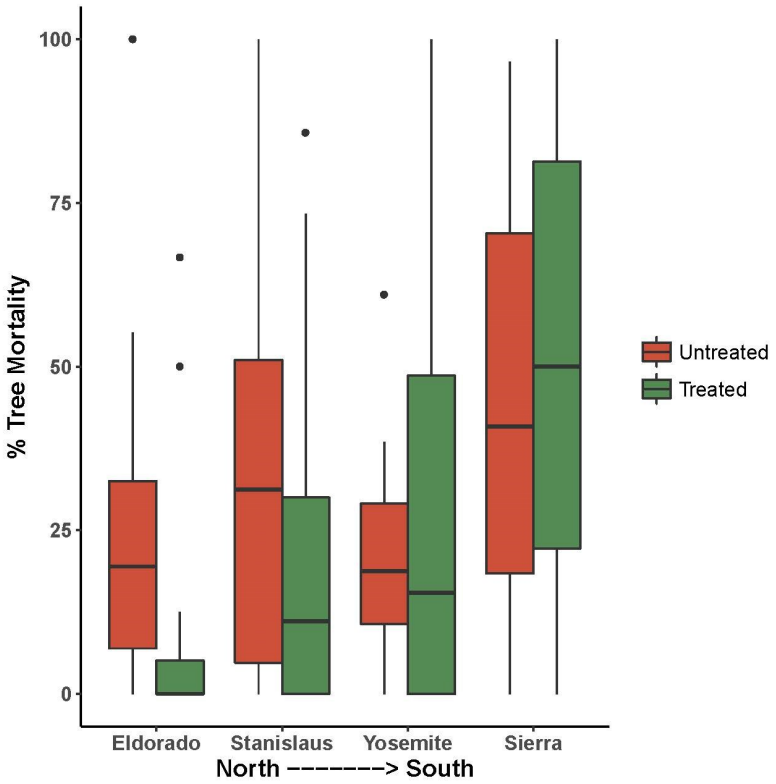
Map of ~300 plots at 13 paired study sites (treated versus untreated) across the Sierra Nevada.

Key Points

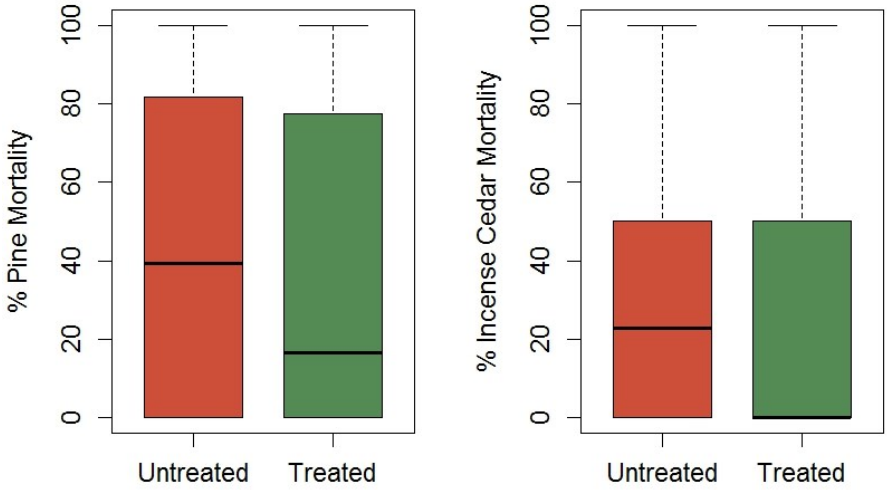
- High tree density leads to more mortality
- Low tree density leads to less mortality
- If water stress is too high density does not matter. Likewise, if density is too high, increased moisture will not compensate for water demand in system.
- There was a gradient in treatment effectiveness from north to south

Overview:

We evaluated if treated forests (e.g. thinned and prescribe burned) were more resistant to the bark beetle epidemic and subsequent mortality. We measured tree mortality in paired units (treated vs. untreated) in the central and southern Sierra Nevada. We found that treated units had lower stand density and basal area and that there was less mortality in treated units in almost all cases. Treatment effectiveness decreased with decreasing latitude, which is closely correlated with climatic water availability. Treatments were only effective when and where annual precipitation exceeded 400 mm, and precipitation in our southernmost sites dropped below 400 mm in 2014 and 2015. An even stronger relationship emerged with climatic water deficit (which combines precipitation and temperature to reflect evaporative demand). Even at low stand densities, the probability of mortality exceeded 90% when CWD reached 900 mm, which occurred in 2013 in the southernmost sites. Our findings demonstrate that forest thinning treatments are efficacious in reducing water stress in forests, but underscore the important interaction between water and forest density.



Treatment effectiveness decreases along a latitudinal gradient of water stress. Sites in the southern part of the study (Sierra NF) experiences significantly higher levels of mortality where water stress was so high that density was less important. Conversely, sites in the north (Eldorado NF) experienced less mortality and treatment was more effective.



Tree mortality was higher in untreated units when summarized across all study sites. Solid line represents the median level of mortality.

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Amarina Wuenschel, Marc Meyer: Southern Sierra Province, U.S. Forest Service Region 5 Ecology Program

Bark Beetle Caused Tree Mortality and Subsequent Fire Severity in Sierra Nevada Mixed Conifer Forests

Data collection on the Rough fire

GOALS

- Quantify the influence of recent bark beetle induced confer mortality on subsequent wildfire severity (i.e. proportion of live trees killed by wildfire);
- Identify pre-fire stand structural, physical, and ecological variables that may influence the mortality -severity relationship

Project Overview

The recent increase in Sierra Nevada tree mortality from bark beetles and drought has caused many resource managers and the public to be concerned about the potential effects on wildfire severity, and they are looking to the scientific literature for information on what level of fire hazard the recently dead trees may pose. However, nearly all of the research to date has been conducted in the Pacific northwest and Rocky Mountains in vegetation types that historically burned at low fire frequency and high fire severity. Information directly applicable to Sierra Nevada mixed-conifer forests, which historically burned frequently at low severity, is lacking.

This in-progress project is designed to investigate the interacting disturbances of insect induced tree mortality and wildfire and specifically to examine whether pre-fire tree mortality affects subsequent wildfire severity. Wildfire severity in this case is defined as the proportion of trees that are damaged or killed by wildfire. The goal of the field study design is to determine whether the presence of recently dead trees in a stand subject to wildfire has an effect on the level of wildfire-caused damage and mortality of live trees in the stand.

During 2016, field crews collected data on two wildfires that burned on the Sierra and Sequoia National Forests in 2015: the ~500 acre Sky fire and the ~150,000 acre Rough fire. Crews determined the pre- or post-fire cause and timing of death for trees within each plot, and recorded multiple other parameters related to overstory and understory vegetation and canopy and surface fire severity. During 2017, data will be collected on additional fires that burned in 2016 in areas of substantial bark beetle induced tree mortality.

Data collection on the Rough fire

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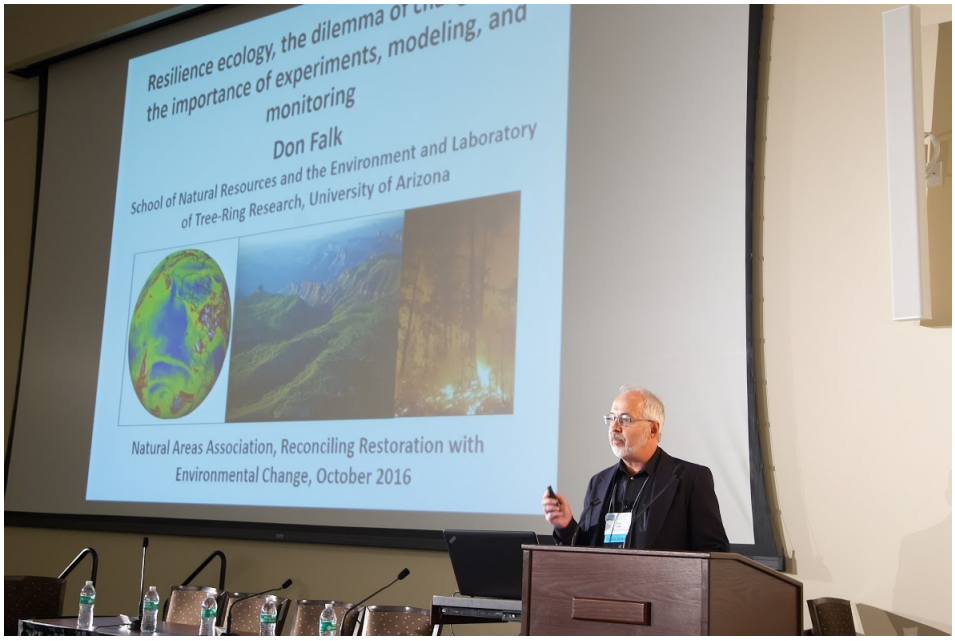
Key Partners: Beverly Bulaon, Forest Entomologist, U.S. Forest Service Region 5 Forest Health Protection
Marc Meyer, Southern Sierra Province Ecologist, U.S. Forest Service Region 5 Ecology Program

Natural Areas Association Conference – Climate Change Adaptation and Natural Areas Management: Turning words into action

The Pacific Southwest Region Ecology Program was one of the key organizers of the 43rd National Areas Association Conference, an annual event that serves as a bridge between science and resource management application. The 2016 conference was jointly hosted by the U.S. Forest Service and University of California-Davis and was the largest Natural Areas Association (NAA) conference in the organization's history with nearly 700 attendees, 2 plenary sessions, 34 organized oral sessions and symposia, associated workshops and trainings, and special events for students and early career professionals. A broad array of topics was addressed, ranging from ecological restoration to climate change adaptation; forest, shrubland and grassland management to management response to sea level rise; pollinators to invasive plants; and tree genomics to the use of native plant materials in revegetation. Attendance included esteemed scientists and land managers from around the world.



Don Falk of the University of Arizona presents during the restoration plenary session

The plenary sessions addressed two major climate related topics

(1) Case studies of adaptation planning and on-the-ground adaptation management in California, focusing on coastal marsh oak woodland & grassland, montane conifer forests.

(2) "Reconciling Restoration with Environmental Change", which reunited international restoration experts in a consideration of six major issues in ecological restoration: The relationship between conservation and restoration; How to manage novel ecosystems; Is traditional restoration dead?; The importance of ecosystem services; Integrating experimentation into management; What is naturalness in an age of ubiquitous human impacts?

Conference organizers from the Ecology Program and the Safford Lab at UC-Davis left: Rebecca Wayman, Christina Restaino, Hugh Safford, and Gabrielle Bohlman

Ecology Program Education and Outreach

One of our most important efforts is in ecological education, within and outside of the Forest Service. Although most of the major issues and problems we deal with in resource management are ecological in nature, the public has a very minimal grasp of what ecology is or how ecological science can be applied in developing solutions. The Region 5 Ecology Program plays an important role in educating agency staff, our partners and stakeholders, and the general public, and we even work internationally. We employ a variety of vehicles, including formal and informal teaching, lectures and webinars, field trips, technical trainings, workshops and seminars, advisement of graduate and undergraduate university students, formal scientific publications, publications in the popular literature, and interviews with the media. Presented here are some of the activities that the Ecology Staff conducted in 2016 and early 2017:

Organization and Leadership of Field trips

- REP staff led three field trips for the CA Fire Science Consortium in 2016-2017: Indiana Summit RNA (Jeffrey pine fire ecology), King Fire post-fire management, Angora Fire effects and restoration. Attendance: 25-70. Partners: various.
- REP staff led a fieldtrip exploring the challenges of fuel and fire management in chaparral landscapes. The fieldtrip highlighted the 2006 Rey Fire (Los Padres NF). Attendance: 30. Partners: UC Santa Barbara.
- *Living With Fire* field trip for Society of Environmental Journalism annual conference, 2016. Attendance: 40. Partners: SEJ, USFS PSW Research Station
- Geo-ecology of northern Sierra Nevada. Attendance: 13. Partners: Chico State University Herbarium.
- Management of fire-adapted serotinous tree species, for scientists and managers from federal agencies and research institutions. Attendance: 15. Partners: USFWS, BLM, Humboldt State University

Mandela Washington Scholars smelling a Jeffrey pine

Publications

- REP staff authored or co-authored more than 25 peer-reviewed scientific publications in applied journals like *Ecological Applications, Forest Ecology and Management, Canadian Journal of Forest Research,* and *Fire Ecology*; also authored one Forest Service General Technical Report and seven book chapters.
- Delivered *Valuing Chaparral: Ecological, Socioeconomic and Management Perspectives* to publisher, book edited by REP staff, to be published end of 2017

Communication with Media

- REP staff gave over ten interviews to newspaper, magazine, radio, and internet journalists on topics including ecosystem management, fire ecology, climate change, and research natural areas..
- REP interviewed for book chapter being written about resource management in the face of environmental change.

Leadership of Workshops, courses, and classes

- REP staff taught several sections of the *Forestry for Lawyers* course, which trains federal environmental lawyers in basics of forest, fire, and wildlife ecology and resource management. Attendance: 35. Partners: USDA Office of General Counsel, US Department of Justice
- Taught forest and fire management section and led field day to Indiana Summit Research Natural Area for Doris Duke Conservation Scholars Program for underserved minorities in science. Attendance: 30. Partners: UC-Santa Cruz, UC-Santa Barbara, Bishop Paiute Tribe, Inyo National Forest.
- Organized *Science Translation and Boundary Spanning in Ecology* graduate seminar for the Graduate Group in Ecology, UC-Davis. Attendance: TBD. Partners: UC-Davis.
- Organized two-day public symposium entitled *The Angora Fire 10-yrs Later: What Have We Learned?* Attendance: 100. Partners: UC-Cooperative Extension, CA Fire Science Consortium, LTBMU, CalFire
- Organized 2-day red fir ecology & management workshop for USFS managers at McClellan AFB. Attendance 65.

Talks and presentations

- REP staff gave invited talks and oral presentations at various national and regional meetings, including the Ecological Society of America, the Natural Areas Association, MEDECOS, the California Forest Landowner's Association, the Northern California Botanists, and the Society for Environmental Journalism.
- Rep staff gave invited lectures to a variety of university courses, including Conservation Biology, Environmental Impact Assessment, Trees and Forests, California Geography, Fire Ecology, and Natural Resource Management.
- Organized FERAL lecture series on forest and fire ecology at UC -Davis. Five lectures in 2016-2017. Attendance: 15-45.

Webinars

- REP staff co-led a webinar on hydrologic modeling and restoration in the Santa Clara watershed for the California Landscape Conservation Cooperative webinar series. Attendance: 75 Partners: USGS, UC-Davis, California LCC.
- REP staff conducted national webinar on using LANDFIRE Biophysical Settings in management. Attendance: 30. Partners: LANDFIRE
- Sierra Nevada section of California Fire Science Consortium (run by REP staff) hosted five webinars in 2016-2017, on topics related to fire science and mgt. Attendance: 15-40. Partners: CA Fire Science Consortium, UC Coop Extension

International education/outreach

- Planned and led seven-day field visit by delegation from Turkish Forest Service (OGM) to learn about planning, management, and climate change adaptation on the California National Forests. Partners: USFS International Programs
- Carried out annual International Climate Change and Nat. Resource Management Seminar, three-week course for international resource managers and policy makers. Attendance: 28, from 23 countries. Partners: UC-Davis, USFS International Programs
- Led forest management, carbon, and fire field days for the Mandela Washington Fellowship-Young African Leaders Program, July 2016. Partners: UC-Davis

Teaching a class on climate change & management